DoMUS a model to communicate energy issues in households

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DoMUS a model to communicate energy issues in households

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Abstract:
Simulation models and games can be a valuable tool to communicate complex issues. Environmental problems in general and the problem described here in particular, are not always easily to explain. To communicate the issue of household energy use, energy reduction and shifting of energy expenditures in the context with sustainability issues, DoMUS (Domestic Metabolism User friendly Simulated) was developed. DoMUS can be used in three ways: as game, as an educative tool and as a personal meter. Depending on goal and target group one of these modes can be used.

Introduction

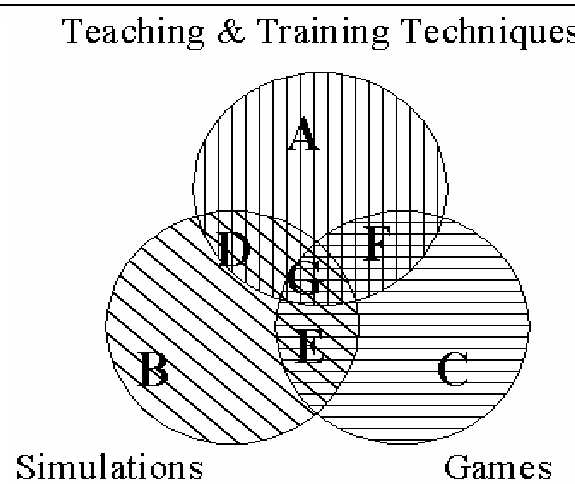
When communicating and/or educating environmental problems you will come upon two problems. First, the complexity of environmental issues which are therefore hard to communicate especially to a layman or nonprofessional. Second, the lack of traditional training & teaching techniques in the category learning by doing which for example are present in chemistry and physics schooling (laboratory experiments).

The complexity is not characteristic of environmental issues alone. In the early seventies ISAGA (International Simulation and Gaming Association) was founded by Richard D. Duke. Duke also wrote some books of which: ‘Gaming: the future language’ an important one was [Duke, 1974]. In this book is argued that the society became much more complex and therefore we need other communication tools and games are such tool. By this group of “Duke adepts”, gaming is seen as the ultimate form for communication.

Figure 1: Communication scheme in which:

A. Traditional teaching & training techniques
B. Computer simulation for research
C. Games (board games like monopoly)
D. Simulation as training tool (flight simulator)
E. Computer simulation games without an educational goal (Simcity)
F. Games for educational purposes
G. Gaming simulations with an educational goal; role-playing with dynamic interaction (STRATAGEM[1] and DoMUS)

[Source: Greenblat, 1981]



In *Figure 1* a scheme is presented in which games and computer simulation are combined with traditional training and teaching techniques, resulting in the overlapping area: educational computer simulation games.

Also in the early seventies, the Club of Rome [Meadows, 1972] wrote their 'Limits to the growth' and they built the famous computer simulation model: World 3. With this model they did all the calculations presented in 'Limits to the growth'. When Peccei, one of the founders of the Club of Rome was asked, at the release of 'Limits to the growth', why they developed this computer model, with all its deficiencies, he stated: *'Our message was received with sympathy and understanding but no action followed. What we needed was a* ***stronger tool of communication*** *to move men on the planet out of their habits'* [Clark, 1975 in Science, 1972].
Meadows became member of ISAGA and by combining both visions he developed the computer based training game: STRATAGEM[1] [Meadows, 1984 and 1996]. This philosophy was adapted by our institute: the Center for Energy and Environmental studies (IVEM).

So environmental simulation models or games suite different goals:
To communicate complexity
As a learning by doing instrument
Environmental studies
Complex, commnuniceren met dbeleidsmakers en maatschappij.
From this concept (simulation & gaming) we look at our research and we ask ourselves if particular research is suitable to communicate with our students. Is this the case than we figure out how to communicate this particular subject. In most cases we decide to communicate them in the traditional form. In some cases, mostly when research models were already built, we use a model with which our students have to practice during one of our energy and environmental courses. If these model do a good job in these courses and we think it can be interesting for others, then we decide to develop a version suitable to be sold. This model can be either in the form of a calculation/research tool (EAP, PowerPlan), a model to develop insights in a certain problems (PowerPlan, DoMUS), a game (Agrosim, DoMUS) or a combination of these options.
It speaks for it selves that the choice to make a model available for others has consequences for the reliability and the user friendliness of the software.

In this paper we describe the DoMUS model. This model can be used to gain insights in the energy use of households. On the one hand the model offers the possibility to determine the yearly total (direct and indirect) energy use. On the other hand it is possible to determine the consequences of a change in household expenditures. DoMUS is made suitable to work in three ways: as an educational tool, as a personal meter or as a game in which the players simulate a given household.

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1 STRATAGEM is a computer aided operational game that educates players in making decisions required to achieve a stable, sustainable, high productivity society. The players form a national administration of a developing country and have all information about cause-effect relationships that govern the success of their decisions. There are no exogenous influences and unknown relationships. Consequently, if a team performs well, it can assume full credit. If it performs poorly, there are no outside influences to blame. A not uncommon outcome is stagnation, with growth in population offsetting all gains in economy. It is even possible to 'crash' the society. If players let debt rise out of control, environment deteriorate too far, labor productivity slip, energy shortages mount and population growth is too high, the economic of the region can spiral downward out of control. And you know who is to blame.

The DoMUS model

DoMUS is not the only software available which gives an indication of the environmental impact of a person or household [Nurmela, 1994 Schlumpf, 1998]. Most similar programs however measure only the energy, CO_2 emission or the so-called ecological footprint of a person or household. These models give the user the possibility to measure his own environmental impact. DoMUS is more than an indicator. Its goal is broader than being an indicator. Its goal is to give insight in:

? the total energy use (direct as well as indirect) of a household;
? the relative importance of several energy consuming products and services;
? the possibilities to reduce energy use;
? the pass of energy to money, with which is meant that saving energy also can save money and the question than is what people are going to do with this 'extra' money? Will they spent it to energy extensive or energy intensive goods and services?

In order to adapt to a situation or target group the model can be used as an educational tool, as a personal meter or as a game. In the educational context we offer students a guided tour illustrated by two fictional households. This tour is completed with some questions. In the personal meter option the user can define his or hers own household at this moment and from this starting point the user can try to reduce his/hers energy use. He/she receive immediately feedback on their decisions on both: energy and money. In the game option the players become member of the same household which are ordered to reduce their energy demand to a certain level with the restriction of spending all (within 5%) their money and within the characteristics of their specific roles.

DoMUS stands for **Do**mestic **M**etabolism **U**ser friendly **S**imulated and is a result of IVEM research of the nineties. Several IVEM projects contributed to this model:

? Energy analysis (EAP model) [Wilting, 1996 and 1999]
? Greenhouse [Nonhebel, 1998]
? Lifestyles [Biesiot, 1995]
? HOMES [Noorman, 1998]

Household energy use in DoMUS

Energy use for households an be divided in direct (for example needed for space heating and lighting) and indirect energy use (for example needed to produce a washing machine, grow vegetables or to deliver services). Each consumptive expenditure of a household goes with a certain energy use. The way a household spends their income determines the amount of energy used by this household.
For the Netherlands the energy use of an average household is calculated [Biesiot and Moll, 1995]. This concerns a household of 2.4 persons. The average energy use is about 240 GJ/hh.year (GJ per household per year) or 100 GJ/p.year (GJ per person per year). In DoMUS 78% of this energy use will be covered, this correspond with 187 GJ/hh.year or 78 GJ/p.year.
Not all national energy use flows through the households or can be imputed to the household

expenditures. This concerns energy used for e.g. the army, health care, education and infrastructure. Furthermore there is an energy flow which flows through the households but is difficult to impute to products or services (For example assurances or savings). When total Dutch energy use will be imputed to the households, then the energy use per household will be 335 GJ or 148 GJ/p [Wilting, 1996].
This means that about 53 % of the total Dutch energy use is covered by the DoMUS model.

In the model the different energy consuming functions are divided into 7 categories:

space heating	energy needed to compensate transmission and ventilation losses, heating equipment;
the house itself	indirect energy for the building and insulation materials and the energy gains from solar PV and sun boilers;
apparatus	apparatus for the functions: cooling, washing, (dish)washing, showering, cooking and lighting;
transport	all transportation's except those for holidays
food	up to 10 different options which deviate from an average meal (e.g. vegetarian);
holidays	up to 10 different types of holiday destinations;
miscellaneous	several options in three sub categories: hobby, sport and others.

Above is described that not all household energy use is taken into account in the DoMUS model. Categories not present in the model, mainly concern the indirect energy use for clothing, furniture, personal care, medical care and maintenance of the house and garden. The reason behind this selection is to obtain a balance between completeness and to much details. So we left out those categories which do not have great potentials for change in energy use as the result of a different expenditure in these categories.

DoMUS the interface

As the acronym DoMUS suggests, we tried to develop a user friendly model. Besides an easy to use interface a short term feedback on decisions made are important. Therefore we offer the user two graphs. One gives an overview of the energy used divided in the seven above described categories (see figure 2). This overview is given for the reference and the actual scenario.

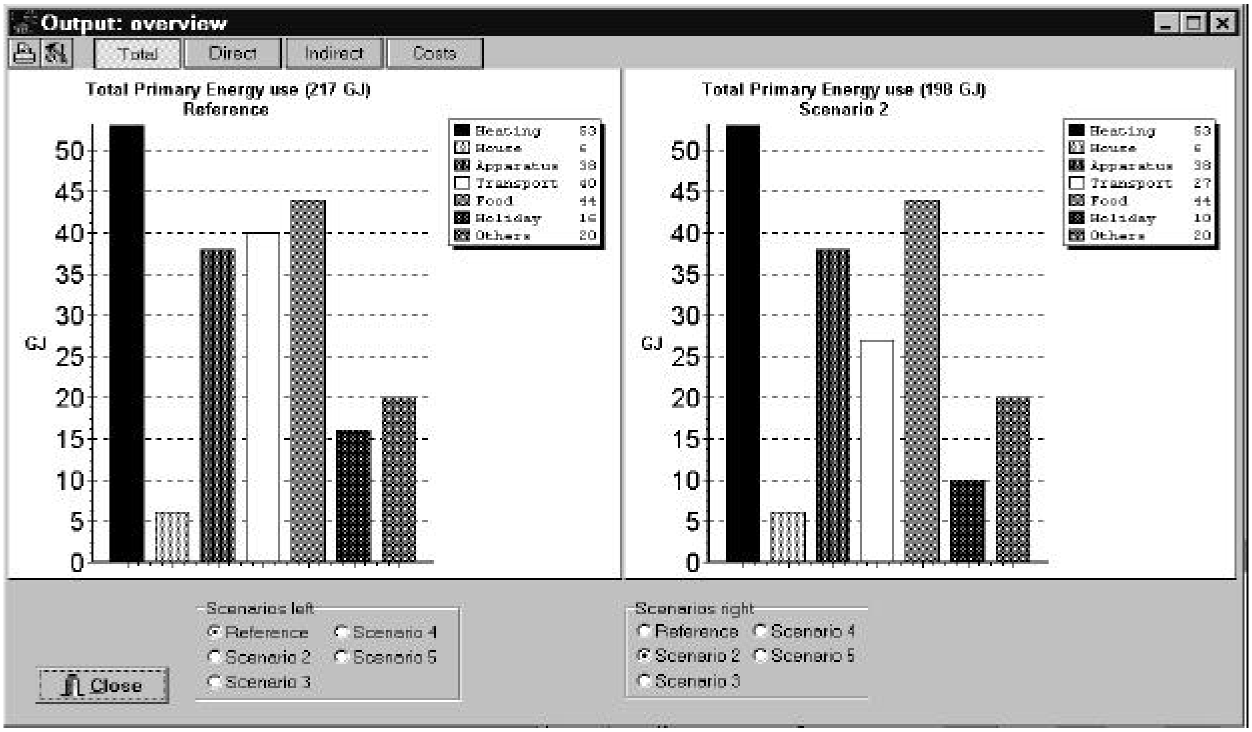

Figure 2: Overview of the costs and energy use for the seven categories

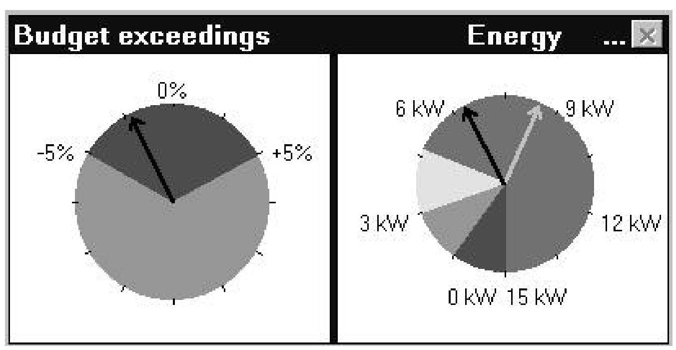

Figure 3: Budget and energy indicators

Figure 3 gives the users in the game mode two meters which show them their target indicators. One meter gives an indications about their budget: is it still between the given budget boundaries of plus and minus 5%. The other meter gives an indication of the present energy use in comparison with the energy use at the starting-point. It also shows the distance to overcome to the goal to be reached (at least 3kW per person which equals 80 GJ per three person household).

To reach the goal (game mode) or to improve your own energy use (one person mode) the user has to change his/hers behavior or his/hers expenditures on the categories as defined in DoMUS. Figure 4 shows the options the users have to adjust their feeding habits.

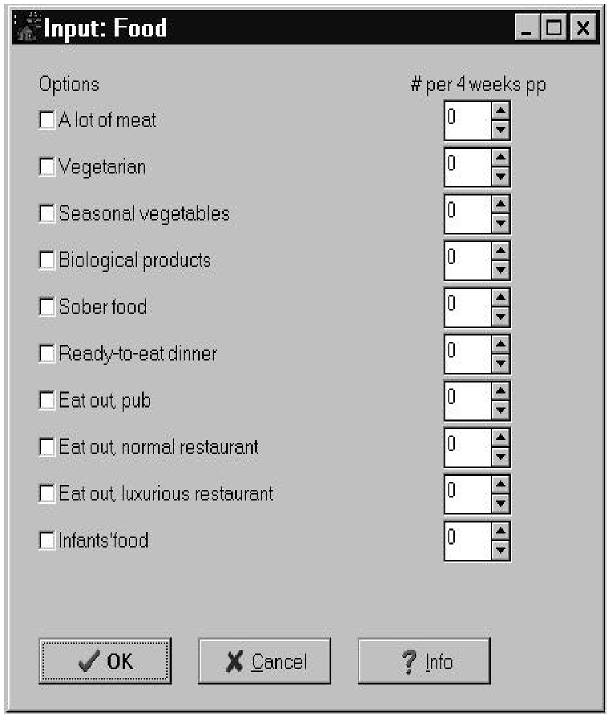

Figure 4: input screen for food options

The default values corresponds with standard national feeding habits when eating at home. Only variations in habits concerning the evening (hot) meal are available. The other meals are no subject for change thus are seen as constant. When selecting one or more options the difference in direct and indirect energy are added or subtracted from the default values.

Figure 5 shows the possibilities the user has to adjust his/hers space-heating behavior.

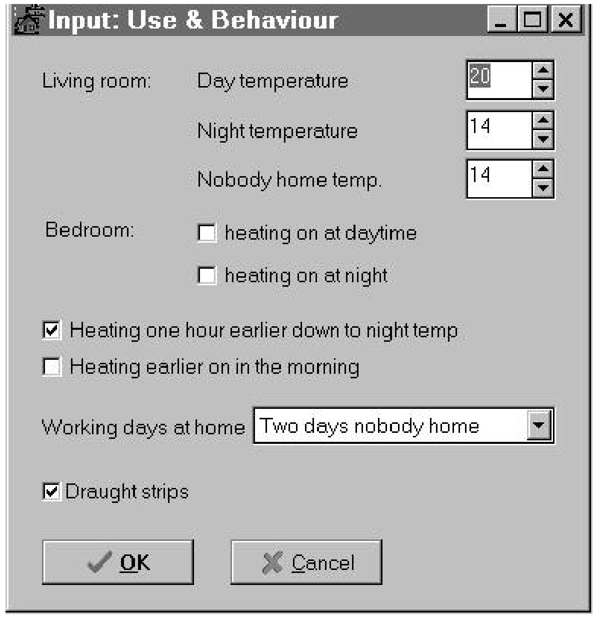

Figure 5: input screen for space-heating behavior

Conclusion and Discussion

Only a part of the reduction of energy use in the household can be achieved by the introduction of better technologies. Even this introduction is subject to consumer behavior. The consumer should select the most energy efficient technology present on the market and not the cheaper more known less energy efficient technology.

On the other hand the consumer can influence his/hers energy consumption directly by changing habits and indirectly by changing expenditures. To give the well-disposed consumer the information he/she needs to become household with a low energy consumption models like DoMUS can be a valuable tool. Although we do not have the illusion to reach every household with DoMUS or such models and games, we believe that such models can contribute to a better insight in the reduction of energy consumption in households.

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